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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII
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POULTRY FEED SUPPLEMENTS

Avocados, Bananas, Papayas, and Sweetpotatoes as Supplementary Feeds for Poultry in Hawaii

By

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POULTRY FEED SUPPLEMENTS

AVOCADOS, BANANAS, PAPAYAS, AND SWEETPOTATOES AS SUPPLEMENTARY FEEDS FOR POULTRY IN HAWAII

By C. M. Bice, *Poultry Husbandman*

INTRODUCTION

The primary object of this experiment has been to determine the possibilities of lowering the cost of egg and poultry production in Hawaii by the larger use of Hawaiian-grown products. It is proposed that certain locally grown feeds such as avocados,[1] bananas, papayas and sweetpotatoes be used to supplement the customary grain-mixture rations usually shipped in from the mainland. The cull and surplus stocks of these fruits and vegetables can certainly be used effectively for this purpose and in many instances these products can be economically produced locally to a sufficient extent to reduce materially the quantity of grain ordinarily brought in from the mainland for poultry-feeding purposes. The present investigation was made to determine the relative and actual feeding value of these locally produced fruits and vegetables for laying hens and also for birds for fattening. Records were kept as to the mortality, yearly production per hen, cost of feed and cost of producing a dozen eggs.

In addition to determining the possibilities of this method in lowering the cost of egg production, attention was given to showing the possibilities of producing marketable poultry of superior quality at a reduced cost per pound of meat. Fresh marketable products of good quality always attract buyers. This is especially true when edible products possessing these desirable qualities are offered for sale, as they appeal to the senses of both sight and taste. Competition from outside sources is less to be feared when the local product offered is fresh, of superior quality, and is placed before the prospective buyer in an attractive and appealing form. Jull and Lee (*5, p. 11*),[2] working with poultry, stated that "fattening is a finishing process designed to prepare chickens for human consumption in

[1] Locally known as alligator pears.

[2] Italic numbers in parentheses refer to Literature Cited, page 24.

the most economical way," and further that "the main object in fattening is to improve the quality of the lean meat." In Hawaii, however, only a few of the larger farms as yet fatten their birds for the market. Birds of high quality can be produced at comparatively low cost in the Territory if they are fed locally grown supplemental feedstuffs.

THE SUPPLEMENTS FED

The same kind of fruits and vegetables were fed to both laying hens and birds for fattening, except that papayas were not used in the fattening rations. Thus, both classes of fowl received avocados (fig. 1) cut in halves; the fleshy edible portion of the bananas, the skin having been discarded (fig. 2); papayas (fig. 3); and whole, cooked sweetpotatoes (fig. 4). All supplements and other feeds were fed from troughs.

COMPOSITION OF SUPPLEMENTS

Samples of avocado, banana, sweetpotato, and papaya analyzed at the Hawaii Agricultural Experiment Station showed the following composition:

TABLE 1—AVERAGE COMPOSITION AND NUTRITIVE RATIO OF AVOCADOS [1], BANANAS [2], SWEETPOTATOES [3], AND PAPAYAS [4]

Supplement	Fat	Carbohydrates	Protein	Ash	Water	Nutritive ratio 1 to —
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
Avocados	26.73	6.76	1.22	1.71	63.58	44.6
Bananas	0.60	22.00	1.30	0.80	75.30	17.9
Sweetpotatoes	0.26	27.83	2.12	0.90	68.89	13.4
Papayas	0.186	8.76	0.388	0.565	89.41	23.65

[1] Hawaii Agr. Exp. Sta. Bul. 51 (1924), p. 16.
[2] Hawaii Agr. Exp. Sta. Ext. Bul. 6 (1917), p. 7.
[3] Hawaii Agr. Exp. Sta. Bul. 50 (1923), p. 15.
[4] Hawaii Agr. Exp. Sta. Report (1914), p. 73.

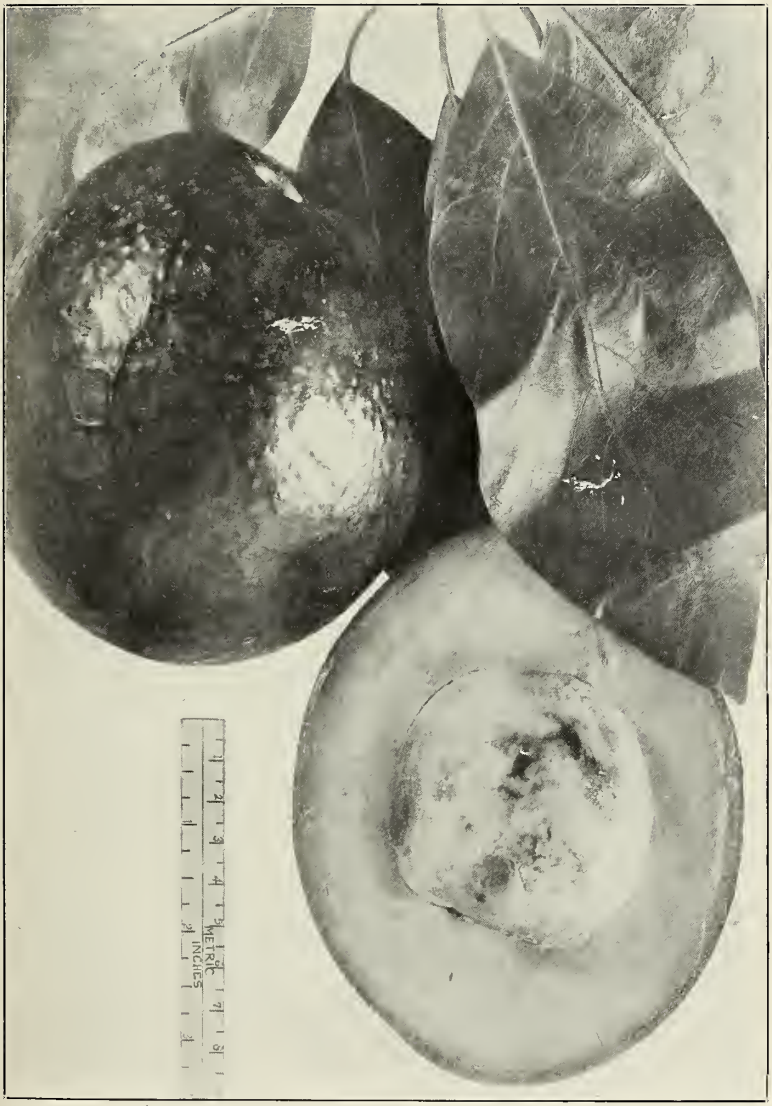

Fig. 1.—Avocado. Showing the exterior, the seed, and the edible portion.

Fig. 2.—A fine bunch of Bluefield bananas.

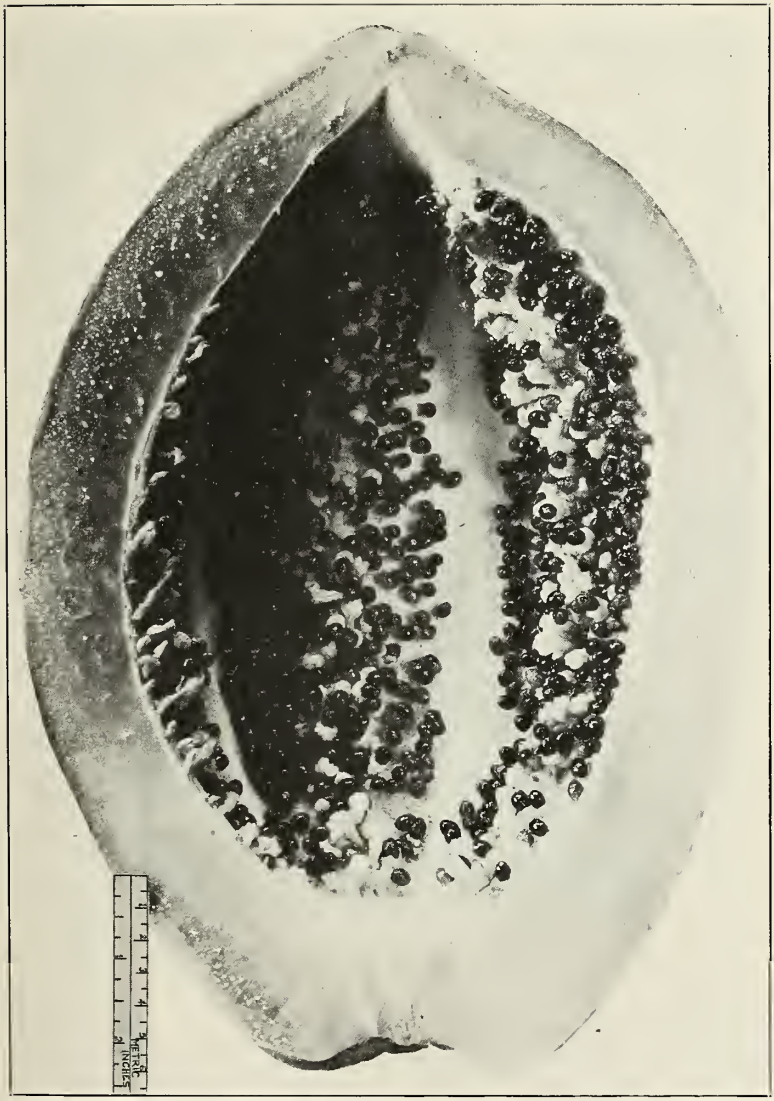

Fig. 3.—A cross section of the papaya with seeds.

Fig. 4.—A cluster of sweetpotatoes.

COST OF FEED

At the prevailing market prices, the cost per pound of feed appears below:

Avocados (culls)	$0.02	Oyster shell	$0.0175
Sweetpotatoes	0.02	Poultry bone	0.035
Bananas	0.01	Grit	0.015
Papayas	0.005	Alfalfa	0.005
Scratch feed	0.02	Wheat middlings	0.015
Egg mash	0.026	Yellow corn meal	0.024
Semi-solid buttermilk	0.078		

RATIONS FOR LAYING HENS

Twelve groups, each of ten Single Comb White Leghorn pullets, were placed on the laying rations for 365 days, beginning October 1, 1930. Birds of equal breeding and showing equal stages of development were assigned to groups and kept under uniform conditions of management. The feeding method for each group of ten hens was as follows:

7:00 A. M.—¼ lb. scratch feed
½ lb. dry mash
⅛ lb. semi-solid buttermilk diluted with 9 parts of water

12:30 P. M.—½ lb. wet mash
1 lb. alfalfa

4:00 P. M.— 1 lb. scratch feed

In addition to the above feeds, oyster-shell flour and poultry-bone meal were placed in the mash. Grit and charcoal were before the birds at all times in open hoppers. Record of the total amount of feed consumed by the 120 pullets is given in Table 2, while the supplements consumed are graphically shown in Figure 5.

TABLE 2.—TOTAL AMOUNT OF FEED CONSUMED BY 120 PULLETS IN ONE YEAR

Group No.	Avocados	Sweet-potatoes	Bananas	Papayas	Scratch	Dry mash	Wet mash	Semi-solid buttermilk	Oyster-shell flour	Bone meal	Grit	Alfalfa
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	123.19	.....	.....	.....	456.25	182.5	182.5	46	31.5	16	10	365
2	164.25	.....	.....	.....	456.25	182.5	182.5	46	31.5	16	10	365
3	273.75	.....	.....	.....	456.25	182.5	182.5	46	31.5	16	10	365
4[1]	.....	.....	.....	.....	456.25	242.5	182.5	46	34.8	18	10	365
5	.....	.....	.....	164.25	456.25	182.5	182.5	46	31.5	16	10	365
6	.....	.....	.....	205.31	456.25	182.5	182.5	46	31.5	16	10	365
7	.....	.....	.....	456.25	456.25	182.5	182.5	46	31.5	16	10	365
8	.....	123.19	.....	.....	456.25	182.5	182.5	46	31.5	16	10	365
9	.....	365.00	.....	.....	456.25	182.5	182.5	46	31.5	16	10	365
10	.....	.....	123.19	.....	456.25	182.5	182.5	46	31.5	16	10	365
11	.....	.....	164.25	.....	456.25	182.5	182.5	46	31.5	16	10	365
12	.....	.....	456.25	.....	456.25	182.5	182.5	46	31.5	16	10	365
Total	561.19	488.19	743.69	825.81	5,475.00	2,250.0	2,190.0	552	381.3	194	120	4,380

[1] Check.

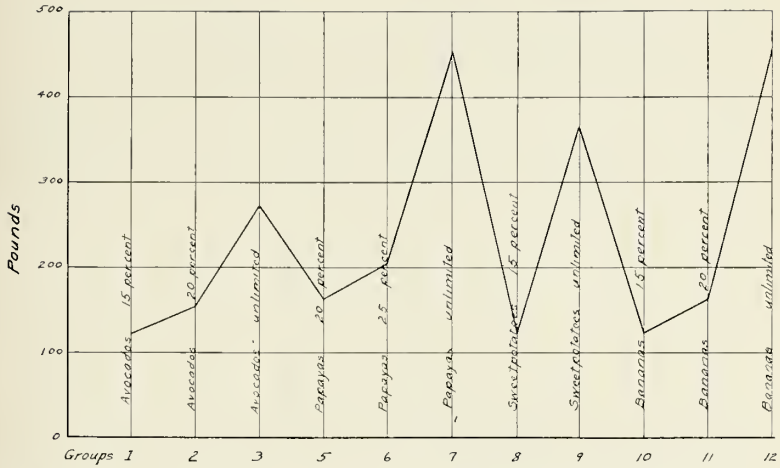

Fig. 5.—Total consumption of avocados, bananas, sweetpotatoes, and papayas per group of ten hens.

The fruits and vegetables were fed in varying proportions to certain groups, but attempts were made to utilize as much of each supplement as possible without destroying the nutritive ratio necessary for high egg production. The birds maintained a good appetite for the supplements throughout the experiment. Commercial feeds were used because they are fed by most poultrymen in the Territory. Thus, the experiment was carried along under conditions similar to those prevailing on local farms. Since avocados, bananas, and sweetpotatoes have a rather wide nutritive ratio, this was reduced by feeding semi-solid buttermilk. Table 3 shows the proportion of supplement to basal ration fed the 12 groups of hens.

TABLE 3.—PROPORTION OF VEGETABLE AND FRUIT SUPPLEMENT AND OF COMMERCIAL MASH AND SCRATCH FEED FED TO 120 PULLETS IN GROUPS OF 10 EACH.

Group No.	Avocado	Banana	Sweet-potato	Papaya	Commercial mash and scratch
	Per cent	Per cent	Per cent	Per cent	Per cent
1	15	.....	.....	.....	85
2	20	.....	.....	.....	80
3	(1)	.....	.....	.....	(2)
4 [3]	....	.....	.....	.....	(2)
5	....	.....	.....	20	80
6	....	.....	.....	25	75
7	....	.....	.....	(1)	(2)
8	....	.....	15	.....	85
9	....	.....	(1)	.....	(2)
10	....	15	.....	.....	85
11	....	20	.....	.....	80
12	....	(1)	.....	.....	(2)

[1] All the birds would eat.
[2] Commercial mash at all times, and in addition scratch feed in the morning and again late in the afternoon.
[3] Check group.

EGG PRODUCTION

A record of the average annual production of eggs, cost of feed, and the gross and net incomes per hen for the 12 groups is given in Table 4, and graphically in Figures 6 and 7.

TABLE 4.—RECORD OF AVERAGE ANNUAL PRODUCTION OF EGGS, FEED COST, AND OF GROSS AND NET INCOME PER HEN FOR 12 GROUPS

Group No.	Av. Production of eggs per hen	Feed cost per hen	Gross income per hen	Net income per hen [1]
	Number			
1	198.8	$2.77	$6.62	$3.85
2	167.9	2.86	5.60	2.74
3	163.9	3.08	5.46	2.39
4	218.1	2.70	7.27	4.57
5	153.7	2.69	5.12	2.43
6	159.8	2.73	5.33	2.59
7	159.7	2.98	5.32	2.34
8	202.6	2.77	6.75	3.98
9	203.8	3.26	6.79	3.54
10	190.7	2.65	6.36	3.71
11	171.8	2.69	5.72	3.03
12	241.0	2.98	8.03	5.05

[1] Average price, $0.40 per dozen eggs.

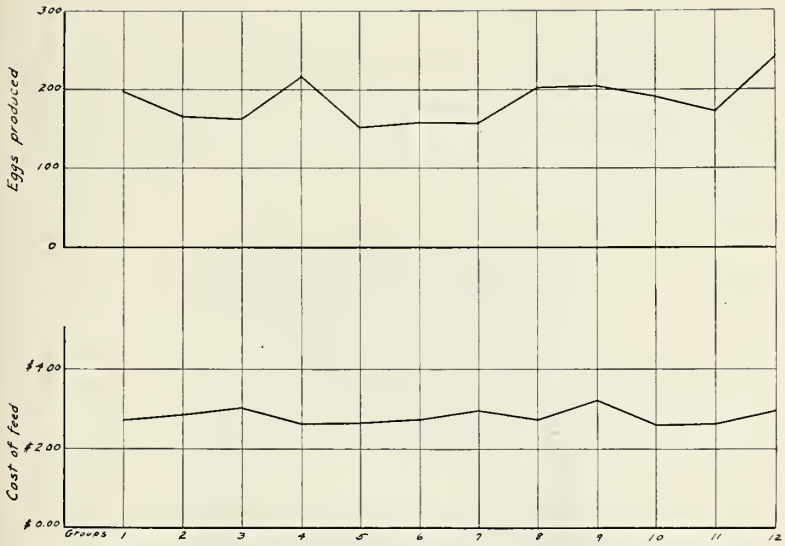

Fig. 6.—Average annual egg production and feed cost per hen.

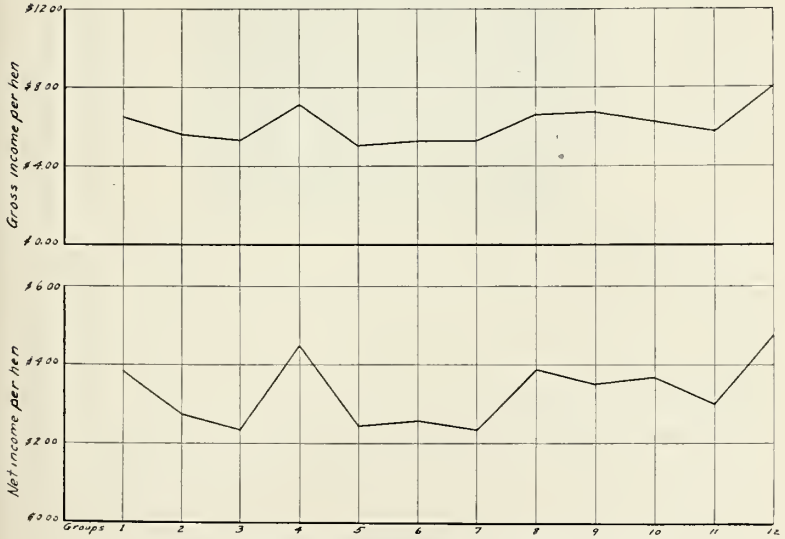

Fig. 7.—Gross and net annual incomes per hen.

The highest average annual production of eggs was made by Group No. 12 (Frontispiece). These birds averaged 241 eggs each. The group was given all the bananas it would eat in addition to various commercial feeds. The birds in Groups Nos. 5, 6, and 7 were consistently low, with an average yield of 153.7, 159.8, and 159.7 eggs, respectively (fig. 6). These groups were fed papaya

Fig. 8.—Highest producing hen, with a record of 324 eggs in 365 days. Fed 15 per cent of avocado and 85 per cent of a basal ration.

(Table 3). The birds on papaya gave the lowest average production of eggs for the year.

Groups Nos. 1 and 2 were fed 15 and 20 per cent, respectively, of avocado, and Group No. 3 all the avocado it would eat. The yearly production per hen for Group No. 1 was 198.8, and 167.9, and 163.9 eggs for Groups Nos. 2 and 3, respectively. Because of the high fat content of the avocado (Table 1), egg production of Groups Nos. 2 and 3 was low. Fifteen per cent of avocado ap-

parently is sufficient as a supplement in rations for high egg production.

The average yearly production of eggs per hen for Groups Nos. 8 and 9 was 202.6 and 203.8 eggs, respectively. Group No. 8 received 15 per cent of sweetpotatoes, and Group No. 9 all the sweetpotatoes it would eat (Table 3). The yearly production of these two groups was consistent and compared favorably with the highest groups fed avocados and bananas. Seven hens produced over 300 eggs. One hen in Group No. 1 produced 324 eggs (fig. 8).

COST OF PRODUCTION

Group No. 1, which received 15 per cent of avocado (Table 3) cost $2.77 per bird (Table 4)—the least of Groups Nos. 1, 2, and 3, Check Group No. 4 had a feed cost of $2.70 per bird. Groups Nos. 5, 6, and 7, fed papaya, increased in cost with the increased proportion of papaya fed them. The feed cost per bird for Groups Nos. 8 and 9, which received sweetpotatoes, was $2.77 and $3.26, respectively. Groups Nos. 10, 11, and 12, fed bananas, consumed $2.65, $2.69, and $2.98 worth of feed, respectively, per bird for the year. Group No. 12, which received all the bananas it would eat, brought the highest net income, $5.05 per hen, whereas Group No. 7, which was given as much papaya as it wanted, brought the lowest, $2.34. The birds fed papaya were consistently low in returns above feed cost. It is concluded that feeding avocados, bananas, and sweetpotatoes to laying hens does not lower the net income.

FATTENING BROILERS AND ROASTERS [4]

Single Comb White Leghorn, Rhode Island Red, and Black Australorp broilers and roasters, varying from 1 to 4½ pounds, were used in the fattening trials, because they are popular breeds on commercial farms in Hawaii. Six trials covering 10 days each were made with 14 fattening rations. The birds were confined in a fattening battery during their respective feeding periods (fig. 9), during which time they received no water. Table 5 shows the composition of the fattening rations.

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[4] "Broilers are young chickens ranging in weight from 1 to 2½ pounds," and "roasters are young birds weighing 4 pounds or over" (*4, pp. 15, 16*).

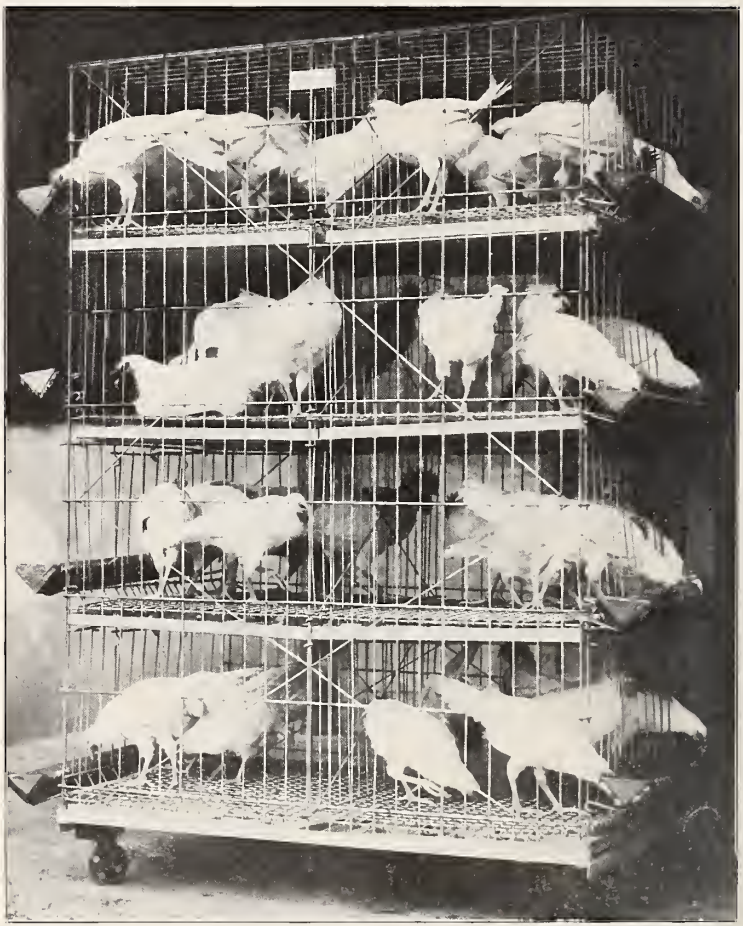

Fig. 9.—Single Comb White Leghorn broilers in a fattening battery.

TABLE 5.—COMPOSITION OF FATTENING RATIONS.[1]

Ration No.	Bananas	Sweet-potatoes	Avocados	Wheat middlings	Yellow corn meal
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1	60	.....	.....	20	20
2	60	.....	.....	.....	40
3	40	.....	.....	20	40
4	40	.....	.....	.....	60
5	40	.....	.....	60	.....
6	.....	60	.....	20	20
7	.....	60	.....	.....	40
8	.....	40	.....	20	40
9	.....	40	.....	.....	60
10[2]	.....	.....	.....	40	60
11	.....	.....	60	20	20
12	.....	.....	60	.....	40
13	.....	.....	40	20	40
14	.....	.....	40	60	.....

[1] Semi-solid buttermilk fed to each group.
[2] Check group.

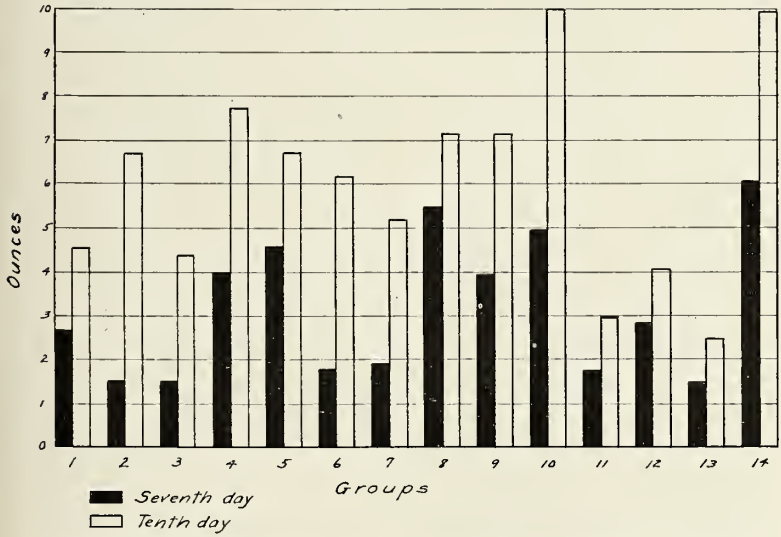

Fig. 10.—Average gain per bird for broilers and roasters for seven and for ten days, respectively, of the experiment.

WEIGHING AND FEEDING

The birds were weighed separately and the average weight was also determined. They were divided as to size and weight so that each group would be of approximately the same initial weight. All

weights were recorded in the morning before feeding was done. Table 6 records the average gain per bird for the first seven days and for the ten days, respectively, of the experiment. The results are graphically shown in Figure 10.

TABLE 6.—AVERAGE GAIN PER BIRD FOR BROILERS AND ROASTERS FOR SEVEN AND FOR TEN DAYS OF THE EXPERIMENT

Ration No.	Average gain at the end of the—	
	Seventh day.	Tenth day.
	Ounces	Ounces
1	2.64	4.60
2	1.56	6.75
3	1.50	4.40
4	4.00	7.70
5	4.60	6.75
6	1.80	6.15
7	1.90	5.20
8	5.50	7.20
9	3.92	7.20
10	4.90	10.00
11	1.71	3.00
12	2.85	4.10
13	1.50	2.50
14	6.14	9.85

Prior to entering upon the experiment, the birds were not fed for 24 hours, but during this period were given access to water. This method was followed to make reasonably certain that the crops would be empty and the birds hungry when they were started on the new rations. Dougherty (*2, p. 17*) of the California experiment station withheld feed for 24 hours from birds about to be placed on fattening rations in order that they might give the best results possible.

The fruits and vegetables were mixed with grain, the amount of which depended upon the kind of ration fed. Each supplement in the fattening rations had a very wide nutritive ratio, which is a desirable factor for fattening. Holst and Newlon (*4, pp. 45, 46*) stated that, in the case of broilers, "the nutritive ratio should be about

1 to 4, and any combination of the ordinary feeds which will give this ratio may be used." For fattening mature birds, however, they suggested the use of a wider nutritive ratio. Semi-solid buttermilk, diluted 1 part to 9 parts of water, was added to each ration until it was of the consistency of thin mortar. Halpin and Lampman (*3, p. 7*) recommended feeding milk in preference to meat scraps after making several trials comparing the nutritive value of both.

During the first day the feed remained before the birds for 15 minutes for each of the three meals. At the end of each meal all feed was removed so that the birds would maintain a keen appetite. On the second day the feeding period was increased to 20 minutes three times a day; and on the third day to 30 minutes each time. From the third to the close of the tenth day three feedings of 30 minutes each were made each day. Throughout the feeding period the birds received no other feed than that given at assigned periods. All feeds were fed from troughs. Records of the amount of feed consumed per pound of gain are given in Table 7 and graphically in Figures 12 and 13.

TABLE 7.—RECORD OF AMOUNT OF FEED CONSUMED AND THE COST PER POUND OF GAIN FOR BROILERS AND FOR ROASTERS

Ration No.	Amount of feed required per pound of gain	Cost of feed per pound of gain
	Pounds	
1	14.70	$0.21
2	12.60	0.20
3	26.10	0.43
4	7.50	0.14
5	8.30	0.11
6	8.60	0.17
7	10.70	0.18
8	7.50	0.14
9	11.20	0.25
10	3.77	0.09
11	7.85	0.16
12	4.63	0.10
13	12.90	0.27
14	4.77	0.09

Before the final weighings were made on the eleventh day, the birds were starved for 18 hours. They were then killed and dry picked (fig. 11).

Fig. 11.—Killing by cutting the jugular vein through the mouth. The brain is then pierced so that the fowl may be dry picked.

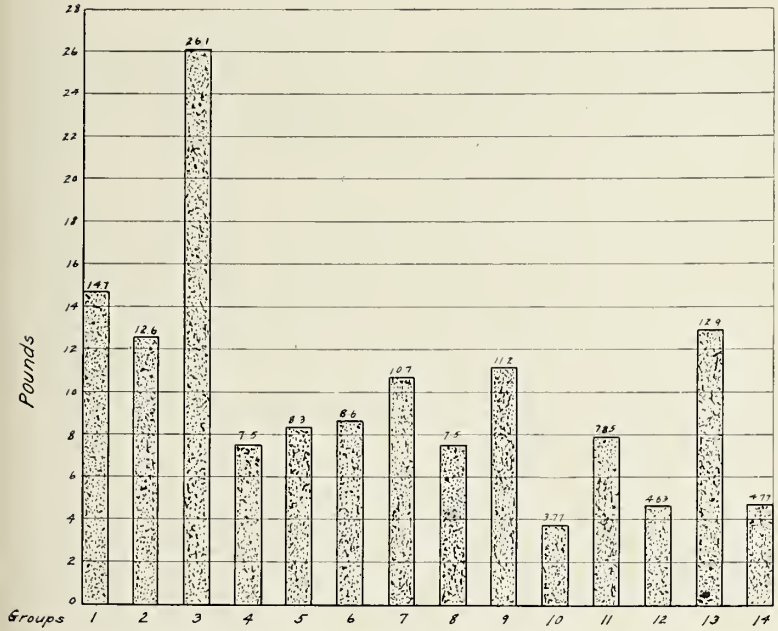

Fig. 12.—Number of pounds of feed required per pound of gain by broilers and roasters.

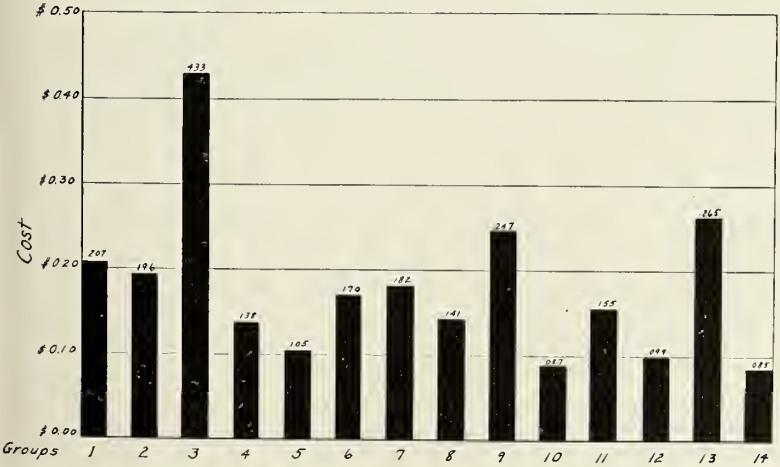

Fig. 13.—Feed cost per pound of gain for broilers and for roasters.

ULTRA-VIOLET RAY EXPOSURE

The birds were exposed to the direct sunlight for 20 minutes each day. At this time the droppings were removed from and clean shavings placed in the pans. Previous work by the author (*1*) indicated that the ultra-violet ray increases bone strength and rate of gain in the process of fattening.

RESULTS FROM THE BEST RATIONS FED

Seven of the 14 rations tried were satisfactorily fed for economical gains in broilers and roasters. Ration No. 14, containing 40 pounds of avocados and 60 pounds of wheat middlings, gave the lowest feed cost per pound of gain, $0.085 (Table 7), whereas ration No. 3 had the highest feed cost, $0.43, per pound of gain. The most satisfactory rations follow:

Ration No. 2.

Bananas	60 pounds	Feed cost, $0.20 per pound of gain.
Yellow corn meal	40 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 4.

Bananas	40 pounds	Feed cost, $0.14 per pound of gain.
Yellow corn meal	60 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 5.

Bananas	40 pounds	Feed cost, $0.11 per pound of gain.
Wheat middlings	60 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 6.

Sweetpotatoes	60 pounds	Feed cost, $0.17 per pound of gain.
Wheat middlings	20 pounds	
Yellow corn meal	20 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 8.

Sweetpotatoes	40 pounds	Feed cost, $0.14 per pound of gain.
Wheat middlings	20 pounds	
Yellow corn meal	40 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 10.

Wheat middlings	40 pounds	Feed cost, $0.09 per pound of gain.
Yellow corn meal	60 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

Ration No. 14.

Avocados	40 pounds	Feed cost, $0.085 per pound of gain.
Wheat middlings	60 pounds	
Semi-solid buttermilk (1 part to 9 parts water)		

CONCLUSIONS

Avocados were satisfactorily fed for high egg production to laying hens when the amounts did not exceed 15 per cent of the whole ration.

Fed as a supplement to egg mash and to scratch grains, sweetpotatoes and bananas were satisfactory for laying hens.

Feeding papaya over a long period of time was found to be detrimental to the health of laying hens, and to result in decreased annual egg production.

Avocados, bananas, and sweetpotatoes were found to make economical supplemental feeds for laying hens.

Fattening rations containing avocados, bananas, and sweetpotatoes, mixed with wheat middlings, yellow corn meal, or with both, proved to be efficient for the production of broilers and roasters of fine quality.

The island-grown feeds used in the experiments were found to contain the necessary nutrients at a low cost for use in feeding laying hens and birds for fattening.

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